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ABSTRACT

This module is the first in a series of eleven modules in an energy conservation curriculum for secondary and postsecondary vocational students. It is designed for use by itself, to be integrated with the other ten modules into a program on energy conservation, or to be integrated into conventional vocational courses as a unit of instruction. The objective of this module is to instill awareness that there is a growing crisis in energy supply. First, an introduction to the module and definitions of key terms are provided. Next, the text is presented in the following two units: (1) an overview of energy supply sources, including oil, gas, coal, nuclear, and hydro-electric power; and (2) a discussion of potential of alternate energy sources such as solar power, wind, geothermal, tidal power, ocean thermal, and biomass. The information in each unit is presented in lecture format accompanied by laboratory exercises and question/examples for class discussion. A bibliography and several charts illustrating the text material are found at the end of the module. (BM)

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Energy Conservation Curriculum for Secondary and Post-Secondary Vocational Students. Module 1.

AWARENESS OF THE ENERGY DILEMMA

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NAVARRO COLLEGE
CORSICANA, TEXAS

April, 1979

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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MODULE #1

AWARENESS OF THE ENERGY DILEMMA

This module is one of a group of 11 modules in an energy conservation curriculum for secondary and post-secondary vocational students. It is intended for use by itself, integrated with the other 10 modules into a program on energy conservation, or integrated into conventional vocational courses as a unit of instruction on the "Awareness of the Energy Dilemma."

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MODULE #1

AWARENESS OF THE ENERGY DILEMMA

The objective of this module is to instill awareness that there is a growing crisis in energy supply. Therefore, attention and concern must be evidenced by all citizens in order for conservation to take place and energy to be available for future use.

MODULE DESCRIPTION:

An overview is made of energy supply sources including oil, gas, coal, nuclear, and hydro-electric power. A survey is made of potential or alternate energy sources which are getting much attention at present. These include solar power, wind, geothermal, tidal power, ocean thermal, biomass, and others. Types and amounts of energy used are discussed and uses of energy are outlined. Finally, an overview of energy opportunities and their problems are listed.

INTRODUCTION:

"The United States' oil production has been declining since 1970, while usage continues to increase. The importing of foreign oil means the exporting of dollars: in 1970, the U.S. spent $3 billion for foreign oil ... $15 for every American. In 1977, the U.S. spent $34 billion for oil, or $160 for every man, woman, and child in the U.S." The U.S., which represents 6% of the world population, uses 1/3 of the world's.

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production of energy. This inbalance presents serious problems in terms of the challenge to America's lifestyles prompted declining sources of inexpensive fuels.

This block of instruction is an introductory overview of the energy problems facing the nation. The module presents a survey of energy resources, an examination of energy uses, and a discussion of the potential for alternate energy sources which are receiving considerable attention at present.

GOAL STATEMENT:

Upon completion of this module, the student will be able to:

a. Exhibit an underrstanding of energy sources and alternate sources available to present day society;

b. Demonstate an understanding of energy uses in the U.S. society;

c. Indicate a better understanding of the disproportionate use of energy today in contrast to cultures and societies of the past and present which were less energy-oriented.

MODULE #1

AWARENESS OF THE ENERGY DILEMMA

TERMINOLOGY

bitumen - any of various mixtures of hydrocarbons (as tar) often together with their non-metabolic derivatives that occur naturally or are obtained as residues after heat-refining naturally occuring substances (as petroleum).

breeder reactor - a nuclear reactor that produces more fissionable material than it consumes.

British thermal unit (BTU) - a unit of heat energy equal to the heat needed to raise the temperature of 1 pound of air-free water from 60 to 61 F at a constant pressure of 1 standard atmosphere.

calorie - a unit of heat energy equal to the heat required to raise the temperature of 1 gram of water from 14.5 to 15.5 C at a constant pressure of 1 standard atmosphere.

coal gas - a gaseous mixture produced by the destructive distillation of bituminous coal and used as a commercial fuel.

cubic foot of gas - a unit of measurement for volume of gas. It is equivalent to 1 foot cubed of volume.

deuteruim - the isotape of the element hydrogen with one neutron and one proton in the nucleus.

energy - the capacity for doing work.

fossil fuels - ultimately derived from living things (coal, oil, natural gas)

geothermal energy - pertaining to heat energy within the earth.

kilocalorie - a unit of heat energy equal to 1000 calories.

nuclear fission - the division of an atomic nucleus into parts of comparable mass; usually restricted to heavier nuclei such as isotopes of uranium, plutonuim, and thorium.

nuclear fusion - combination of two light nuclei to form a heavier nucleus (and perhaps other reaction products) with release of some binding energy.

nuclear power - power whose source is nuclear fission or fusion.

oil shade - oil produced or captured from a fissile rock that is formed by the consolidation of clay, mud, or silt, has a finely stratified or laminated structure, and is composed of minerals essentially unaltered since deposition.

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solar energy - pertaining to the heating property of the sun.

strip mine - a mine that is worked from the earth's surface by the stripping of overburden.

water-power - pertaining to the energy capability of water and its volume, weight, or temperature stratification.

wind power - pertaining to the energy capability of wind with its movement.

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MODULE #1

AWARENESS OF THE ENERGY DILEMMA

UNITS:

1. Energy Sources

   A. Changing Energy Sources/Uses
   B. Fossil Fuels
   C. Fossil Fuels in Texas

      1.) Oil and Gas in Texas
      2.) Coal in Texas

   D. Energy Depletion Rates
   E. The Energy Crisis

2. Renewable/Alternate Energy Sources

   A. Biomass Conversion
   B. Solar Energy
   C. Wind Energy
   D. Ocean Sources

      1.) Ocean Thermal Energy Conversion
      2.) Tidal Generators

   E. Geothermal
   F. Nuclear

      1.) Conventional Reactors
      2.) Breeder Reactors
      3.) Nuclear Fusion

   G. Oil Shale
   H. Tar Sands
   I. Problems

SUMMARY

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MODULE #1

AWARENESS OF THE ENERGY DILEMMA

UNIT 1

ENERGY SOURCES

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Recognize the conventional sources of energy in the U.S.

2. Discuss the historical change in dependency on these fuels.

3. Relate the role of Texas in the U.S. production of energy.

4. Appreciate the rate of fossil fuel depletion.

5. Discuss the three types of energy crisis existing today in the world.

LECTURE

INTRODUCTION:

The United States' oil production has been declining since 1970, while usage continues to increase. In 1977, the United States imported about fifty percent of its total oil consumed. This dependency on foreign oil imports has a serious disadvantage. The tremendous trade deficit produced makes it impossible to achieve a balance of trade under these conditions. The result is a serious blow to the stability of the United States' currency in the international market, is a threat to our defense posture, and makes energy conservation extremely important.

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Is there really an energy shortage? In reality, there are worldwide shortages. The problem is not only a shortage of oil and natural gas; other important energy sources are also declining. Conservation cannot solve all of our energy problems, but it can help. Conservation does not mean doing without things, but using what we have more efficiently.

Voluntary energy consumption, however, in only one approach to coping with the energy crisis. Research is being conducted on future possibilities for electricity supplied through solar and geothermal energy, wind power, breeder reactors, oil shale, coal liquification, and nuclear fusion by using the unlimited deuterium hydrogen resources in the sea.

It is impossible to be unaware of energy. Newspaper and magazines print articles about the energy crisis and the methods by which we hope to solve the problem. Meanwhile, utility bills rise rapidly, goods and services cost more, and personal paychecks lose buying power.

Many people think of energy simply as a power plant or a steel mill, an electrical generator or a tank truck on the road. Actually, wherever we have heat, light, or motion, we have energy in action. We need to recognize that energy is present in a lump of coal, a battery, or a piece of uranium. This energy can provide us with heat, light, or motion and must be used conservatively to be most efficient.

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The chief sources of energy throughout the world in order of importance are: fossil fuels, water power, and nuclear energy. In addition, solar energy, wind power, tidal energy, and geothermal power provide small amounts of energy. (Figure 1.1) Histoical perspective indicates that emphasis on fossil fuels, water power, and nuclear energy is strickly a contemporary focus.

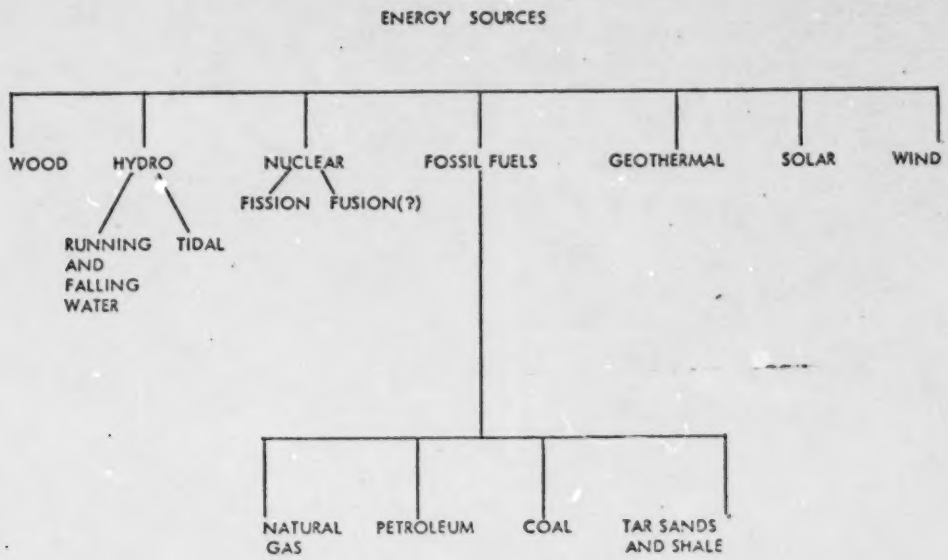

FIGURE 1.1

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A. CHANGING ENERGY SOURCES/ USES

In the most primitive society, life for man was very much like that of the animals in the same area. Man consumed about 2000 kilocalories of energy per day in food through life processes and hunting for survival. With the use of simple stone tools, social organization progressed with some division of labor: hunters, gatherers, preparers. The event of fire was the first external source of energy which man used to aid him in his labors. This one item accounts for the additional 3000 kilocalories of energy of the 5000 kilocalories total which each primitive man spent per day.

Each advancement in social organization brought with it an increase in energy input. A simple plow drawn by an ox enabled one person to provide food for several, but oxen used energy while providing power which is compared to energy input. With each additional input of energy, fewer people were able to produce and provide more items and services for more people, thus freeing people for other pursuits. This process has increased through industrialization and technology until the average American today consumes some 220,000 plus kilocalories of energy per day.

Today, about 95% of the energy supplied for our use comes from the fossil fuels -- oil, natural gas, and coal. (Figure 1.2) This is a dramatic change in energy sources in the United States over the past 125-150 years, and the implications of these changes have been the basis of our present energy dilemma.

LABORATORY

A calorie is:

1(a) The amount of heat required at a pressure of one atmosphere to raise the temperature of one gram of water one degree centigrade -- called also "gram calorie" or "small calorie".

1(b) The amount of heat required at a pressure of one atmosphere to raise the temperature of one kilogram of water one degree centigrade -- 1000 gram calories or 3.968 BTU -- also called "kilogram calories" or "large calorie".

A kilocalorie is:

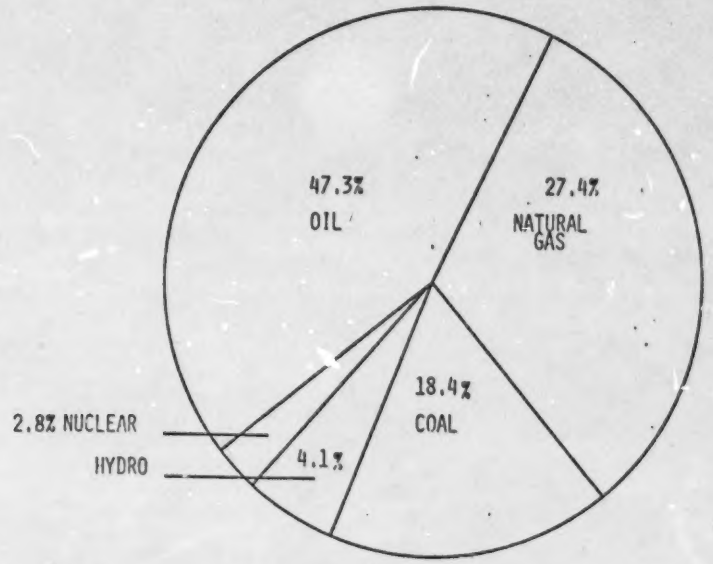
2(a) A unit equivalent to the large calorie expressing heat-producing or energy-producing value in food when oxidized in the body.

2(b) An amount of food having an energy-producing value of one large calorie.

Hence, when we speak of "kilocalorie" we are speaking of the large calorie. Early man found his 2000 kilocalories for survival when and where he could. Today, because of all of our demands to "live the good life", the average citizen of the United States consumes between 220,000 and 240,000 kilocalories of energy each day. By "consumes" we mean that man uses this much energy, or requires the use of this much energy, in order to follow a daily routine (cooking food, running appliances, transportation, performing work, etc.).

HOW U.S. ENERGY NEEDS ARE SUPPLIED

HOW MUCH OF OUR ENERGY COMES FROM EACH SOURCE?

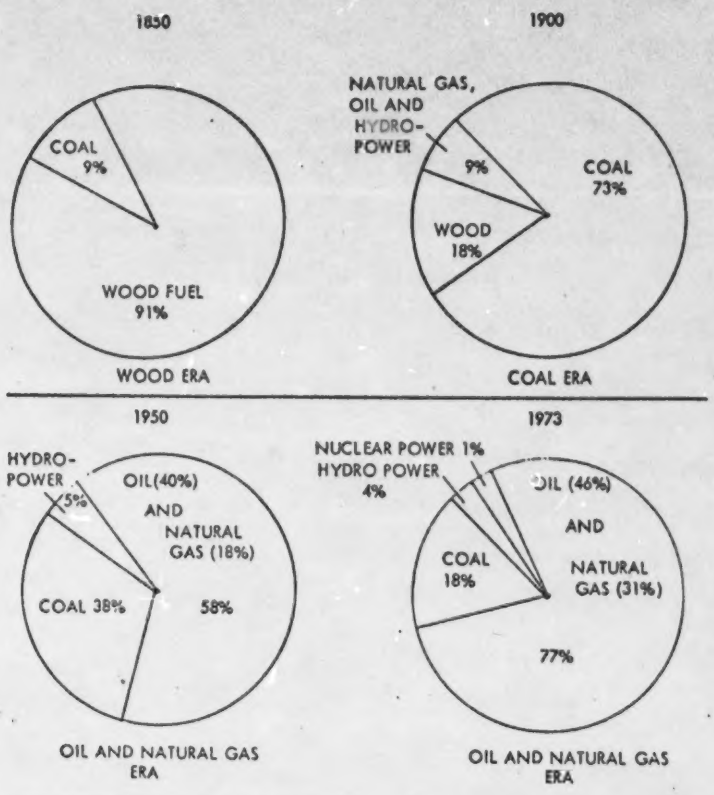


U.S. TOTAL ENERGY SUPPLY

FIG. 1.2

In 1850, the major fuel source available was wood, even though some hydropower was used to turn wheels for mills, and the use of steam engines. Wood was inexpensive and widely available though some shortages developed periodically near growing cities. As long as wood was the major fuel, the ratio of manpower expended to energy produced remained low. Coal was required in some instances and required a large input of manpower to produce. Coal, however, was less bulky than wood for a given energy content and was easily transported and stored. The increase in manufacturing and industry from 1850-1900 was as much due to better and large energy supply in the form of coal as it was to the inventiveness that provided the machinery. (Figure 1.3)

CHANGING PATTERNS IN THE USE OF ENERGY RESOURCES IN THE UNITED STATES*



What will the year 2000 bring? NUCLEAR FISSION ERA? NEW COAL ERA? NUCLEAR FUSION, GEOTHERMAL, SOLAR, WIND ERA? ENERGY CONSERVATION ERA? LOWER PER CAPITA ENERGY USE?

Data from the U.S. Bureau of Census and Resources for the Future.

FIGURE 1.3

From 1900-1950 the shift was made fom coal to oil and natural gas as the major energy source and the total energy consumed in the United States increased about 300%. The major reason for this change for coal to oil and gas was still the manpower -- energy produced ratio and ease of transportion and storage. Since 1950, energy consumption has increased by nearly 400% over the 1950 level and an even greater share of energy has been produced from oil and natural gas. (Refer to Figure 1.3)

In 1973, the U.S. experienced an oil embargo by the oil producing countries of the world. Discuss the inconveniences and frustrations you experienced by this action.

The political situation in Iran promises to have the same type of effect on the U.S. in 1979 and 1980. Is the U.S. better prepared in 1979 to face the situation than in 1973? Explain.

B. FOSSIL FUELS

More than 60 percent of the world's oil reserve lies in the Middle East and North Africa. The reliance by industrialized nations on Arab oil gives the Middle Eastern nations considerable power. As fuels become scarce, prices go up.

In 1974, Arab oil accounted for 14% of all U.S. imports. Currently, it is over 40% and growing rapidly. Altogether the U.S. imports over half the oil it consumes and is currently paying over $40 billion a year for it. At the current rate of increase in consumption and oil prices, we can expect to be paying about $120 billion for imported oil by the year 2000, as compared to spending $25 billion in 1974.

Natural gas provides 1/3 of our nation's energy needs. If gas energy is to continue serving the essential needs, plus new uses being developed for the future, where will supplies come from? Obviously, the most desirable source would be from new fields or more deeply developed reserves. The most promising potential sources of gas in this area are three basins on the outer continental shelf -- Georges Bank, east of New England and New York; Baltimore Canyon, east of Maryland, Delaware, and New Jersey; and Blake Plateau, east of Georgia and Florida. Experts estimate that exploration and development of the Atlantic offshore basins might produce up to 200 trillion cubic feet of gas and 50 billion barrels of oil. Gasification of coal is another means of gas production, but it is a long-term goal.

Locate these natural gas reserves on a United States. map. What problems in transporting the gas to the customers do you see?

Coal has been in use at various places on earth for over 800 years, but over 1/2 of the coal has been mined in the past 40 years. Even though coal has been providing less and less of our total energy supply, the amount of coal mined each year has been increasing. Much of it comes from the southern region of the United States Texas has figured prominently in the U.S. production of fossil fuels.

It would be interesting to ask the class how many had never seen a piece of coal or smelled it burning.

C. FOSSIL FUELS IN TEXAS

Although energy in Texas is abundant, it is not unlimited. Texans should be aware of the energy sources in the state and have a concern about energy use and conservation in order that the years ahead will be pleasant and profitable. Texas has an energy problem to solve because Texas plays a big role in the energy picture in the United States both as a producer and consumer. With conservation and efficiency in the use of its energy sources, Texas can maintain its position as a major supplier of energy to the nation. With improved technology to bring about new sources of energy, coupled with the wise use of the energy Texas now has, the future should be a bright one not only for Texas but for the entire nation.

1.) Oil and Gas in Texas

The Indians were the first to find oil in Texas. When the explorers arrived, the Indians told them the oil had medicinal values. History has recorded that Europeans exploring Texas used crude oil for the caulking of boats, such as in 1543, in the De Soto expedition near Sabine Pass.

The first drilled well to produce oil in Texas was at Melrose, in Nacogdoches County. To reach the oil, the driller, Lyne T. Barret, used an auger which he fastened to a pipe and rotated by a cogwheel driven by a steam engine. His technique was a basic principle of rotary drilling which is still used today.

In 1867, a well was dug at Oil Springs in the same county and as other wells were brought in, Nacogdoches County became the site of the first commercial oil field in Texas.

It was not until the year 1894 that Texas had a major oil discovery. A water well being drilled for the city of Corsicana brought in oil instead of water and the well was abandoned. In 1895, a company drilled several oil producing wells, and it was there that the first well-equipped refinery in Texas was built. The Powell Field near Corsicana was discovered in 1900.

The most famous date in Texas petroleum history is January 10, 1901, when oil gushed from Spindletop, near Beaumont. This was the first salt dome oil discovery, and it was this well which encouraged exploration and drilling in Texas that has continued ever since that time.

The East Texas oil field, biggest of them all, was discovered near Turnertown and Joinerville, Rusk County in 1930. This discovery was followed by the biggest leasing campaign in history. The field was extended from Rusk County to Kilgore, Longview and Northwood.

Are these oil fields still in operation today? Why or why not?

The most important oil discoveries made since that time have been in West Texas in Scurry County, the major one being in 1948, which brought about later developments in that area.

Natural gas as a temporary energy source is also a fossil fuel. Millions of years of pressure on organic material has formed a mixture of gaseous hydrocarbons, made up mostly of methane which is called natural gas. Through combustion it releases its stored chemical energy.

Today, the energy and products provided by the basic mineral fuel of crude petroleum and natural gas permeate the economy of Texas.

2.) Coal in Texas

Coal is the most abundant of the fossil fuels. It took nature millions of years to transform organic materials such as trees and other plant life into a hardened or concentrated form called hydrocarbons. The combustion of these hydrocarbons releases its stored chemical energy.

Before oil and gas were used significantly in Texas, coal was an important energy source. Beginning in 1895 and lasting through 1943, more than 24 million tons of coal were produced. The early coal mines have been inactive for many years, but coal is receiving increased attention as a major source of energy in the state.

Deposits of bituminous coal have been found in North Central Texas, which includes Coleman, Eastland, Erath, Jack, McCulloch, Montague, Palo Pinto, Parker, Wise, Young, and nearby counties. Because the coal deposits in North Central Texas are no more than 30 inches thick and have a high ash and sulphur content, problems are present for efficient surface mining and land reclamation.

In South Texas, bituminous coal was produced in the Eagle Pass area of Maverick County and Webb County during the late 1800's and early 1900's. The thickness there ranges from 4 to 7 feet and further exploration may be feasible in the future.

It is believed that the coal deposits in the Trans-Pecos country of West Texas around Brewster County and Presidio County are not adequate to hold any potential for future development.

Lignite, which is a low-grade coal, is found in two belts in Texas which extend across the Texas Gulf Coastal Plain from the Rio Grande River near Laredo in South Texas to the vicinity of the Arkansas and Louisiana boundaries in East Texas. The greatest amount and the highest grade lignite are found mostly north of the Colorado River in East and Central Texas.

Known commercial deposits of lignite are found in Bastrop, Freestone, Harrison, Henderson, McMullen, Milam, Panola, Robertson and Titus Counties.

There are additional lignite resources on the Texas Gulf Coastal Plain including Bastrop, Fayette, Houston, Lee, Leon and Madison Counties. These lignite deposits could be used as potential energy sources for the future.

Locate these coal deposits on a Texas map.

What problems in transporting this source of energy do you see? Is coal historically an easily transportable source of energy?

Three large strip-mines are producing lignite that is burned for electric power generation. These are located in Milam, Freestone, and Titus Counties. A large mine is being developed in Panola County, and there will be mines developed in Henderson, McMullen, and Robertson Counties.

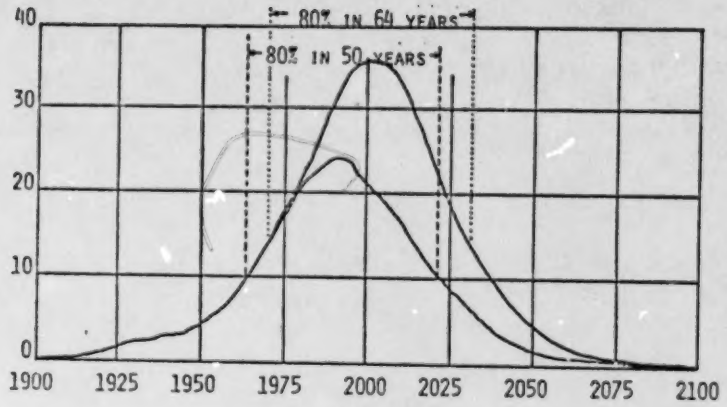
D. ENERGY DEPLETION RATES

It is important to point out that heavy dependence at present on fossil fuels, a finite non-renewable resource, means they will eventually be depleted. No matter what additional supplies may be found, no matter what new technologies may be developed that increase recovery or extend the useful period, the fossil fuels are a finite resource and their availability must decrease with time. Figures 1.4 and 1.5 show curves which represent the high and low estimates of possible reserves, recovery, and use of coal and oil in the U.S. In the long run, it makes little difference which of the predictions is more correct. The fossil fuels will run out. As more nations (and therefore more people) become industrialized, the consumption of these easily obtained energy resources will increase markedly and the depletion rates may change accordingly. It should also be noted that coal is a major storehouse of raw organic materials and may rapidly become far more valuable as a chemical source than as a fuel to burn. A similar situation exists for natural gas.

Annual production of natural gas in the United States went from 6,262 trillion cubic feet in 1950 to 22,600 trillion in 1973, then began a decline, reaching 20,100 trillion in 1975. Crude oil production peaked at 3,577 million barrels in 1971, and then declined to 3,356 million in 1973, and 3,052

DEPLETION RATES

CYCLE OF WORLD OIL PRODUCTION

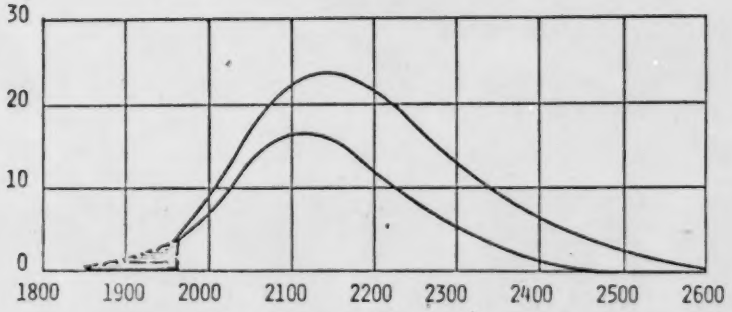


PRODUCTION (10^M BARRELS PER YEAR)

FIGURE 1.4

DEPLETION RATES

CYCLE OF WORLD COAL PRODUCTION



PRODUCTION (10^M METRIC TONS PER YEAR)

FIGURE 1.5

million in 1975. Coal production has increased, however, from 560 million short tons in 1950 to 598 million in 1973 and 646 million in 1975.

The tread in energy use is clear. Per capita consumption in the United States has risen from 180 million BTU in 1925 to 300 million BTU in 1973. The average per capita figure for the world, by contrast, was 23 million BTU in 1925 and 55 BTU million in 1968. Comparisons between the average American consumer and any other citizen of the world are rather dramatic, as Figure 1.6 demonstrates.

This chart may be the most frightening chart available. Can you name comforts and convenient uses of energy enjoyed in the U.S. which other countries do not enjoy? Your list could be inexhaustible.

FIGURE 1.6

HOW MUCH ENERGY DOES EACH PERSON USE IN A YEAR?

An American	300 million BTU/year
A German	150 million BTU/year
A Russian	130 million BTU/year
A Puerto Rican	100 million BTU/year
A Chilean	40 million BTU/year
THE WORLD AVERAGE	35 million BTU/year
A Chinese	13 million BTU/year
An Indian	5 million BTU/year
A Nigerian	1.5 million BTU/year
A Nepalese	.3 million BTU/year

Source: "Energy Conservation: Understanding and Activities for Young People", (FEA/D-75/264) U. S. Government Printing Office, Washington, DC 20402

As per capita energy consumption increased along with electrification, so did inefficiency in energy conversion. The gap between gross and net energy consumed per capita in the United States has risen from approximately 25 million BTU in 1947 to approximately 65 million BTU in 1975. Technical conversion losses have increased considerably, even since the 1973 "crisis," as consumption of natural gas and electricity generation have given way to oil and coal -- both less efficient fuels.

In 1968 residential consumption was more than 19 percent of the national total, with commercial use accounting for 14.4 percent, industrial use 41.2 percent, and transportation 25.2 percent. By 1973, the household and commercial sectors together consumed 30 percent of the U.S. total, the industrial sector accounted for 39 percent, and the transportation sector had grown to 31 percent.

What are some of the reasons for these sharp increases in energy use? By recognizing the uses, the student will be able to identify conservation measures later on.

The growing gap between domestic production and consumption has led to an increased dependence on imports, especially petroleum. Petroleum products supplied 14 percent of the nation's total energy in 1920, but the figure had risen to 46 percent by 1973. To meet the petroleum demand, imports of relatively inexpensive crude oil from outside the country, especially Venezuela and the Middle East, increased rapidly. Petroleum imports rose from 8 percent of domestic demand in 1947 to 36.8 percent in 1975, and was expected to reach 46.1 percent in 1977 although imports in fact passed the 50 percent mark in 1977. The United States imports roughly 5 percent of its natural gas supply as well. U.S. depen-

Now that China has been recognized by the U.S., how will this Western culture influence the Chinese per capita energy consumption? Is political ideology connected with or influencial on the amount of energy a country uses?

dence on foreign supplies came sharply into focus during the Arab oil embargo in the winter of 1973-74, which created widespread shortages of gasoline and heating fuels.

Prices escalated sharply, then dropped slightly and leveled off, but remained well above pre-embargo levels. The wellhead price of domestically produced crude oil increased 72 percent from 1973 to 1975, and imported crude oil increased even more dramatically. Libyan crude oil, for instance, rose from $3.77 a barrel in January 1973 to $13.71 a barrel in January 1976. Coal prices in 1975 were $16 to $18 a ton free on board (transportation not included) for underground coal and $10 a ton for surface-mined coal, compared with the 1971 average price of $6 a ton. Nationwide, electric utilities paid an average of $18.61 per ton for coal in mid-1976.

The price of natural gas continues to be determined and somewhat confused by the regulatory bodies and long-term contracts that are characteristic of the natural gas business. For 1975 the Federal Power Commission (FPC) set the base ceiling rate to 50 cents per 1,000 cubic feet (MCF) of natural gas that began flowing in interstate commerce after December 31, 1972. This represented an 8-cent increase over the regulated 1974 price. The wellhead price of new gas has since been raised by the FPC to $1.42 per MCF. The average price paid for imported gas entering regulated pipelines increased from 59 cents per 1,000 cubic feet in September 1974 to $1.41 a year later and to $1.80 on January 1, 1977. The price of intrastate

What are the present prices of oil? How often do they change? What are some of the reasons for oil price change? Is the situation of oil pricing by oil producing nations a type of blackmail for the rest of the world? Explain.

gas continued to vary widely. For example, in 1976 1,000 cubic feet of natural gas (at retail) cost $3.01 in Austin, Texas, while in Amarillo, Texas, the same quantity of gas could be purchased for 50 cents.

Why are there such price differences between Amarillo and Austin? (LaVaca Gas Company).

E. THE ENERGY CRISIS

The situation described above, where the supply of energy does not keep pace with the demand, has caused an energy crisis. Actually, three different energy crises are occurring simultaneously in our country and each requires a different solution.

The first type of crisis is the chronic crisis. This crisis forces the populace to reconsider building designs, building materials, and the balance of national and individual resources. It is resolved by a progressive improvement building design and energy consumption, and it requires constant improvement.

How does each of these crises effect the average American citizen in the home?

The second type of crisis is the chronic crisis. This crisis forces the populace to reconsider building designs, building materials, and the balance of national and individual resources. This crisis can be resolved by a progressive improvement in building design and energy consumption. Solutions to this kind of crisis require constant revision.

The third type of crisis is terminal crisis. That is the ultimate situation where all fossil fuel is depleted. The solution is to realize it will happen and to be prepared to switch to alternate energy sources and self-sufficiency. The social and political implications of this crisis are frightening if intelligent steps of preparation are not taken. Figure 1.7 summarizes these three crises.

FIGURE 1.7

THREE TYPES OF ENERGY CRISIS

TYPE OF CRISIS	CONSEQUENCE	ACTION
ACUTE	NATIONAL BANKRUPTCY	TURN DOWN OR SWITCH OFF
CHRONIC	HIGH ENERGY COSTS REQUIRING ADJUSTMENT IN BALANCE OF USE OF BOTH NATIONAL AND INDIVIDUAL RESOURCES	DESIGN BUILDINGS TO BE THERMALLY EFFICIENT
TERMINAL	EXHAUSTION OF FOSSIL FUELS	DEVELOP ALTERNATIVE AND RECYCLABLE SOURCES OF ENERGY

SOURCE: PETER BURBERRY, BUILDING FOR ENERGY CONSERVATION, 1978.

A major concern is the failure of the United States to take significant steps to reduce energy consumption. The U.S. wastes billions of energy units daily while other nations are going without. The industrial nations of the world have 30% of the world's population but use 80% of the energy. The U.S. has only 6% of the world's population but uses over 1/3 of the energy consumed in the world. Figure 1.6 showed that an American uses as much energy for air conditioning as China uses in total, and China has four times our population. India, with 15% of the world's population, uses only 1.5% of the world's energy; or each American consumes as much energy as do sixty residents in India. Energy use and consumption of natural resources might be better balanced if the United States practiced strict energy conservation measures and used renewable energy sources.

Does the worldwide concern about the U.S. attitude toward energy use effect the value of the U.S. dollar on foreign money markets? Can the sudden surge in the value of the German mark, Swiss franc, and Japanese yen have any relationship to their efficiency rate of energy use?

UNIT 2

RENEWABLE/ALTERNATE ENERGY SOURCES

OBJECTIVES: Upon completion of this unit, the student will be able to:

1. Recognize alternate sources of energy used and proposed for today's use.

2. Understand some of the problems related to these alternate sources of energy.

LECTURE

INTRODUCTION:

If alternate sources of energy could be found to replace some of the oil used daily, and if the use could be cut down in some areas, this could help restore the economy to a sound position. Restoring the economy is a good motive for conservation, but everyone should be motivated by something even more important to the development of the country and of the world -- the rapidly dwindling natural resources. A world without energy resources will not happen tomorrow, and you and I may not be around to see it, but our grandchildren might be. Future generations will certainly feel the results of our negligence and selfishness unless we begin right now to conserve energy and to search for sound solutions to today's wasteful use of energy.

A. BIOMASS CONVERSION

Wood is one renewable energy source. If we carefully plan our use of the forests and replant fast growing species whenever cutting is done, we

LABORATORY

TURNING TRASH INTO USEABLE ENERGY

THINGS YOU NEED:

Household trash (see text). A shallow baking dish. Aluminum foil.

should be able to supply our needs for lumber for the future and the construction industry. Though we will not be able to count on wood for burning as a replacement for coal and other fossil fuels, wood could supplement other sources.

One hundred years ago over 75% of America's energy was from burning wood. Today less than 1/3 of 1% of the nation's energy comes from wood. However, 4.6 million tons of residential, commercial, and industrial solid waste is wood accumulation. This is 3/4 as much as is used yearly for wood products.

A 6- to 12- acre lot of land could produce enough wood to heat one home indefinitely. Hardwood has 1/12 the heat value of coal and 1/3 that of oil; soft wood has less. Plants and wood wastes can be turned into methane which can in turn supply a family with fuel for cooking and lighting. One ton of solid waste, which includes wood and wood by-products, yields 10 million BTU's. If incinerated to generate electricity, 10% of 1970's solid waste in the U.S. could hve yielded 25 billion kilowatt hours, or 1.5% of the U.S. electricity production that year.

As we said earlier, many of the things we throw away every day can be burned to produce heat. They are a source of energy. This simple experiment proves the point. It shows one way of converting trash into fire fuel.

The first step is to put on a pair of gloves and rummage through your trash cans. Look for paper or cardboard items (that aren't too dirty or messy). For example:

-Can labels
-Cardboard boxes
-Paper cups or plates
-Toilet tissue wrappers
-Paper towels
-Flour or sugar bags

You get the idea...the list can go on and on.

Using scissors, cut these items into pieces that will fit neatly into the baking dish. But don't put them into the dish yet. First, soak them in water until they are soggy. While the paper pieces are soaking, line the dish with aluminum foil to keep it clean.

Then place layer after layer of soggy paper into the dish. Use your fingers to press the layers together and to force the excess water out of the soggy mass. Pour this excess water out. Stop adding layers when you've built a pile that's about 3/4" thick.

Now we want the compressed pile to dry out. For this demonstration only, let's speed up the drying process. Let's use an oven (better check to see if it's okay to use the oven for this purpose). Bake the pile for about an hour. Oven temperature should be around 200°F. DON'T USE A MICROWAVE OVEN. Because of the aluminum foil, the microwave tube inside the unit could be damaged.

After taking the dish out of the oven and after the contents have cooled down, lift the pile out of the dish. If it is still damp, set it aside until completely dry. When dry, chunks of this salvaged waste paper will burn like wood. You can use them in a fireplace, campfire, or whatever.

When making additional piles, skip the oven part. (You don't need the baking dish either; use something else.) Simply let the piles dry outside in the aluminum foil liner. It doesn't make sense to consume more energy using the oven than you get from the fire fuel.

B. SOLAR ENERGY

Solar power is a source of energy that is being tapped with renewed interest. There are special construction and building specifications that must be followed for solar power and in certain areas of the nation where the sun does not shine for extended periods in the winter time, supplemental power must be called upon to fill the energy needs.

There are no major technological barriers to using solar for hot water heating, space heating, and air conditioning. Turning the sun's energy into electricity through photovoltaics is possible but expensive at present. With the emphasis government is placing on this source and tax incentives which have been enacted, solar could furnish a large portion of the nation's energy needs by the 1990's.

Solar energy is nonpollutant and generally available to everyone. Its use is not new, dating back to 770 B.C. in Rome when solar reflectors were used to light the sacred fire in the Temple of Vesta.

A MODEL SOLAR HOT WATER HEATER

THINGS YOU NEED:

About 10' of flexible black tubing. A shallow cardboard or wood box about 12" by 18". Flat black paint, and paper or cloth for the inside of the box. A piece of window glass to cover the box. Spring-type wooden clothespin. Tape. Two empty cans of buckets, thermometer.

The experiment will help you understand how solar hot water heaters operate.

You can easily build a model solar energy collector. Start by covering the insides of the box with black paint, paper, cloth, or other dark material. Then loop the tubing back and forth inside the box. Arrange for both ends of the tubing to be sticking out of the sides of the box a couple of feet.

Next place the glass cover on the box and secure it with tape. It is ready for a test.

Today solar is used extensively in Japan, Israel, and Australia; in the 1920's solar hot water heaters were used in Florida, Arizona, and New Mexico. Presently it is a competitive and conventional energy source for space heating in the Canadian border states of the extreme northeast and north central regions of the U.S. Between 1980-1985, it will become feasible in the middle belt states, and after 1985 in the southern sun belt states.

Wait for a sunnyday and find an open area. Place the collector on a stand, with a can or bucket of water next to the collector. Put one of the tubing ends into the water. Suck gently on the other end to establish a siphon action. Once water starts to flow through the tubing, pinch the tubing partially with the clothespin to limit the flow of water to a small trickle.

Notice that after a while, the water trickling from the tubing will be warmer than the water siphoning into the collector. Test the temperature of the water.

How warm the water gets will depend mostly on the time of year, how clear the skies are, and how slowly the water flows through the collector.

Once the bucket is a quarter full of warm water use it to replace the bucket of cold water, and set an empty bucket as a collection bucket. Take the temperature of the water. How many degrees did it rise in temperature?

Although wind energy is clean and appears to be free, there are many problems to be solved:

-The wind-powered generators available today are expensive.

-They are large.

-They don't generate electricity unless the wind is blowing. obviously.

-It is costly to store excess energy-that is, energy generated but not immediately needed.

For those reasons, experts believe that wind generators will be useful only in limited situations.

C. WIND ENERGY

Wind power is being tested in several areas again, but wind is not dependable. It does not blow all the time and allowances must be made for adjusting to the strength of the wind. Wind is one servant that may turn on its users in the form of tornadoes, cyclones and hurricanes, and destroy the equipment needed to channel its use.

Wind power is one of the world's oldest energy systems. Through the times of Thomas Jefferson, the only important source of industrial power other than the water wheel was a windmill. By 1900, a large windmill industry existed in the United States with a capital investment of over $4 million. By the 1920's, wind power had become a major source of electrical power on farms and homesteads across the United States. These small scale generators served well for years, providing cheap, clean electrical power to thousands of rural and farm homes. However, the establishment of the Rural Electrical Administration (REA) in 1930 made federally-subsidized, centrally-generated electrical power available to farms.

The two major problems with wind power are costs and storage. How do you keep the lights on when the wind stops blowing? There are several storage technologies. The most familiar is lead-acid batteries, which can be charged while the wind is blowing and then be used at a later time. Unfortunately, these can cost as much as the wind machine itself. Another alternative is to use pumped water or air -- either pump water up into a reservoir and

CONVERTING WIND ENERGY INTO ELECTRICITY

THINGS YOU NEED:

Model airplane propeller about 6" long. Two nails 1" long. Two nails 3" long. Four small nails. Small bar magnet 1" long. Two metal strips 1 1/2" by 4", cut from a tin can. Magnet wire. Germanium diode type 1N23A (most electronic stores carry this inexpensive part). Tape. Glue. Soldering iron and solder. Wood block about 3 1/2" by 5".

This model wind generator works much like the new "wind turbines" for generating electricity. When the propeller spins, the magnet whizzing past the nail head generates a tiny alternating current (AC) in the coil wound around the nail. The small germanium diode connected across the two nail terminals converts the AC into DC (direct current), which is what is needed in this experiment.

To make the wind generator, begin by wrapping 1000 turns of magnet wire around one of the large nails. The coil should be 2" long, measured from the head end. Leave a few inches of wire for connections. Twist them so they won't unravel.

Drive this nail into the center of the wood block. Also drive in the two smaller nails where shown.

After scraping the enamel insulation off the ends of the coil wires, wrap the bared ends around the nail heads. Then hook the diode across the nails, and make all connections secure by soldering.

Next, glue the bar magnet to the head of the other large nail. Be sure the magnet is centered on the head and the glue is given plenty of time to set. This will be the propeller shaft.

then let it fall to turn the turbines as needed (as is presently done with many conventional power plants), or use the wind machine to compress air that can be stored in tanks or natural caverns, and then fed into gas turbines as needed. Cost of wind power generators should be competitive with fossil fuels and nuclear plants when the components are mass produced. Low maintenance and zero fuel costs make this machine attractive for future development.

D. OCEAN SOURCES

1.) Ocean Thermal Energy Conversion

Since the 1820's, mechanical engineers have been building heat engines based on the concept that mechanical energy can be extracted from the flow of heat energy between a hot and a cooler region. The oceans' heat is of solar origin. In tropical latitudes the water surface has a relatively constant temperature, close to 80°F, but at 3,000 or more feet below sea level, the temperature drops to the low 50's. Although small, this 35°F differential constitutes the elements of a heat engine.

The shaft is supported by the two tin-can strips. Fold them in half lengthwise for added stiffness. Then bend about 3/4" for the base. Nail them to the wood block, in line with the upright nail.

Insert the shaft in the supports till the magnet is directly over the nail head. Two collars of electrical tape will keep the shaft in place. Finally, drill a hole in the propeller so that it fits snugly on the nail.

Now for the test. Connect a galvanometer's alligator clamps to the two nail terminals. Keep the compass about a foot away from the magnet. Have the galvanometer coil lined up with the compass needle.

Set the generator in the wind or in front of a fan. (Or wrap a couple feet of string around the shaft and pull upward, like trying to start a power lawn mower.) When the shaft turns, you'll see the compass needle deflect. This demonstrates that electricity can be produced from the wind.

THE IDEA BEHIND OCEAN THERMAL ENERGY CONVERSION:

THINGS YOU NEED:

An empty narrow-mouth plastic bottle. A balloon. A bucket filled with hot water. Another bucket filled with cold water.

Put the empty bottle and balloon in a refrigerator. Leave them there for at least one hour. They both must be cold.

Before removing the bottle and balloon from the refrigerator, prepare the buckets of hot and cold water. Add a handful of ice cubes to the cold water to make it colder.

An Ocean Thermal Energy Conversion (OTEC) power plant would operate a heat engine by utilizing the energy that can be made to flow between the warm solar-heated surface water of tropical and subtropical oceans, and the deep, underlying colder water. A working fluid, such as propane or ammonia, would be vaporized by the warm surface water, the pressurized vapor would turn a turbine, and the cycle would be completed by using the cooler water to condense the gas back to a liquid. The laws of thermodynamics act to make this a very low efficiency machine but the consistency of the temperature and the availability of unlimited volumes of water at the surface and at depths gives this machine immense energy potentials. A demonstration plant could be testing ocean thermal energy equipment in an ocean environment by the mid to late 1990's. Present U.S. Electrical production capacity is 500,000 Mw.

Taking the balloon in your hand, squeeze it to drive out any air it may contain. Then quickly slip the neck of the balloon over the mouth of the cold bottle.

Immerse the bottle in the hot water (it's okay if the balloon is in the water too). In a few moments, you'll see the limp balloon begin to inflate.

When the inflation stops, immerse the bottle in the cold water. The balloon will slowly shrink and become limp again.

Repeat the hot and cold immersion steps.

This experiment shows that heated water expands a working medium (the air inside the bottle) and makes it do "work" (blow up the balloon slightly). Cool water restores the medium to its original volume so that it can work again when reheated.

The experiment also demonstrates the principle of operation of a real ocean thermal energy conversion system: The heated liquid turns into an expanding gas, which "works" by turning the turbine. When cooled, the gas condenses back into a liquid, shrinking in volume.

A power plant uses ammonia as the working medium (this is not the same as household "ammonia", which is really ammonium hydroxide). The process begins with the ammonia in liquid form, at a temperature of 40°F.

1. Warm seawater at the surface heats the liquid ammonia to a temperature of 80 F. This heating turns the ammonia into an expanding gas.

2. The expanding gas rushes the turbine, making it spin. The turbine is connected to an electric generator. As the turbine spins, so does the generator. thus producing electricity.

3. Cool seawater from the deep, chills the ammonia gas and turns it back into a liquid.

4. Same as step 1...the cycle starts all over again.

Although this process could generate much electricity, building a large ocean thermal energy conversion plant would be very difficult and expensive. Still, the concept holds promise in the warm parts of the world.

This simple experiment uses air as the working medium to demonstrate the principle on which ocean thermal energy conversion is based.

2.) Tidal Generators

In some parts of the world, it's possible to harness the ocean's tides to make electricity. The idea is simple: First, build a dam across a bay. Then use the water that "piles up" against the dam to turn electric generators.

During high tide, the water builds up on the ocean side of the dam. It is allowed to flow into the bay by passing through turbines that turn electric generators.

During low tide, things are reversed. Now, the water trapped on the land side of the dam again passes through the turbines as it flows back to the ocean.

Two tidal energy conversion plants hve been built overseas. They prove that the idea works, But not all bays are suitable for this kind of energy conversion process. In fact, there are only about a dozen places in the United States where this kind of power plant could be built. The tides must be high enough to create a worthwhile difference in water height. And the bay must be narrow enough for a practical dam to be built.

E. GEOTHERMAL

If we imagine the earth as an orange and the peeling of the orange as the only really cool part of the earth on its surface, the remainder of the orange represents very hot liquid rock which is a tremendous heat source. Geothermal energy, the heat deep inside the earth, is a vast potential source of useful power which should become available for a wide variety of important applications as economic exploitation technologies are developed. This internal energy of the earth is thought to be the result of the natural decay of radioactive materials. Thus it is virtually inexhaustible, although the heat content of a particular reservoir might be depleted after several decades of active use.

Theoretically, such energy could be obtained at any point on earth by drilling deeply enough and providing some arrangement for extracting the heat. In most parts of the world the hot interior mass is too deep to reach with existing drilling technology, but in some areas, including many places in the western U.S., large heat sources occur close to the surface. The exact locations and sizes of these sources are not yet completely established.

GEOTHERMAL ENERGY

The United States has 1.8 million acres of land where geothermal energy is known to exist in various forms. This leads to the belief that geothermal energy may eventually become an important source of electricity. Some estimates indicate that 30% of our electricity will come from geothermal energy by the 21st century.

GEOTHERMAL STEAM ENGINE

THINGS YOU NEED:

An empty soup can. Heavy aluminum foil (frozen food tray, pie pan, etc.). Aluminum wrapping foil. Straight pin. An 8" length of still wire (coat hanger). Stick about 12" long. Small pot. Glue. Tape. Rubber band.

With a little imagination and a model turbine, you can get some idea how steam can produce electricity. First, you'll have to build the model.

1. If not already off, remove the lid from the soup can. Rinse out the can.

2. Turn the can upside down and punch two 1/8" holes opposite one another in the bottom. Locate each hole about 1/4" away from the rim.

3. From your frozen food tray or pie pan cut out a flat disk equal in diameter to that of the can. Pierce a hole in the center of the disk with a straight pin.

4. Take some aluminum wrapping foil and wad it up into a little ball the size of a small cherry. Glue this ball to the disk, centered right over the hole. It will prevent the disk from wobbling badly.

5. After the glue has dried, put the pin in the disk hole and push it through the ball. Try to get the pin as perpendicular to the disk as you are able. Now enlarge this hole slightly with a thicker pin or needle. The idea is to have the disk and ball spin freely on the pin.

6. Make eight equally spaced "pie cuts" in the disk with a pair of scissors. Cut all the way to the ball.

7. Twist each "pie wedge" slightly to form the turbine wheel (see drawing).

8. Bend the still wire, as shown. Make sure that when the wire is later attached to the can, the small downward segment will point to the can's center.

9. Slip the straight pin through the turbine and tape it to the support wire. Then tape the support wire to the can so that the turbine is as close as possible to the can without touching it. Blow on the turbine to test it. It should spin quite easily.

10. Fasten the stick to the can with a rubber band or string.

11. Now for the steam. Put a cup or two of water in a small pot. Before heating the water, cover the top with aluminum foil. pinching the edges all the way around. Make a pencil-sized hole in the center.

12. Bring the water to a boil. When steam starts jetting from the hole, lower the can over the hole, using the stick as a handle. The steam pouring from the two holes in the soup can will start the turbine spinning.

F. NUCLEAR

1.) Conventional Reactors

Regardless of how they are fueled, most generators function in much the same way. Basically, heat is used to boil water into high pressure steam. The steam passes through the blades of a turbine, causing the shaft, on which the turbine blades are attached, to turn. The rotating part of the electrical generator is on the same shaft so it spins along with the turbine, generating electricity. The spent steam is condensed to water and returned to the steam generator.

In a fossil power plant, either coal, oil or gas are burned in a furnace to boil water to steam. In a nuclear plant, the furnace is replaced by a reactor which produces heat through a chain reaction of the nuclear fuel. This chain reaction is regulated at all times with control rods, which stop the fission process when completely inserted into the reactor core. The nuclear fuel most commonly used today is uranium-235, which occurs in nature. In a nuclear reactor, the fuel atoms fission, that is, they split apart and this process releases tremendous quantities of heat to make electricity.

The technology necessary to build nuclear plants is well established. Currently there are about 70 power reactors operating in this country and they are supplying more than 10% of our electricity. That's the equivalent of burning 1 million barrels of oil <u>every day</u>. Nuclear power is growing; it now supplies twice as much electricity as it did 2 years ago, and

You'll have to imagine that in an actual power plant, high pressure steam blasts against a series of such turbine wheels on the same shaft. The shaft, in turn, drives an electric generator, which produces the electricity. It's amazing how powerful steam is.

its contribution is expected to increase. In the year 1985 it is projected that 125,000 Ms of nuclear generating capacity will be in service and will produce 665 billion kilowatt hours that year. If this were to be generated instead of fossil fuel generating plants, it would require the equivalent of 2.75 million barrels of oil each day.

One common question asked about nuclear power is: Is it safe? One need only examine the nuclear safety record of the industry. With over 300 commercial and 1300 naval reactor-years of operation, no member of the public has ever been injured or killed by a nuclear power plant.

Discuss these questions as they relate to your community.

2.) Breeder Reactors

When conventional fuels such as wood, coal, oil, or gas are burned, their energy is used up and cannot be renewed. Imagine, however, "burning" a fuel that actually creates a greater supply of fuel than is consumed. This can be done in Breeder Reactors, a kind of nuclear "furnace" now being developed. It is called a "breeder" because it produces more fuel -- in the form of plutonium -- than it consumes.

Actually the breeder reactor is not a new idea. The liquid metal fast breeder reactor has been under development for over 25 years. In fact, the first electricity produced by nuclear power was from a reactor of this type -- the Experimental Breeder Reactor I -- in Idaho in 1951. Unfortunately, the breeder development is faced with a dilemma. The plutonium fuel needed for breeder reactors could also be used for nuclear explosive devices. For this reason the United States is seeking a better approach to the next generation of nuclear power than is provided by the plutonium breeder.

What are the trade-offs involved in developing nuclear as an alternate source of energy?

3.) Nuclear Fusion

Fusion is a nuclear reaction. It is, in a sense, the opposite of fission. The release of energy in fission occurs because a large nucleus (uranium, for instance) is split into two smaller ones. In the fusion reaction two very small nuclei combine to form a larger one. In both cases, the mass of the end product(s) is less than the mass of the original reacting nuclei and this lost mass is converted into energy.

The fusion reaction was first scientifically demonstrated and studied 45 or so years ago. It has glimmered brightly before us for almost 30 years, giving hope for a return to the Eden of abundant energy. But to date, the only man-made, self-sustaining fusion reaction has been the explosion of a "hydrogen bomb."

Fusion uses "fuels" which are essentially inexhaustible. It appears to be relatively benign environmentally and safe. It does not (unless it is designed to do so) produce materials which can be side-tracked for bomb making. Only solar energy, in fact, can compete with its promise. But the achievement of this promise, on a commercial scale, is surely the most difficult technical task that our species has yet undertaken. Many more years of research and development will be required before fusion power plants will be a practical validity.

G. OIL SHALE

In addition to coal-based synthetics, the United States has the option of utilizing additional fossil solids in the form of oil shale and tar sands. Oil shales are misnamed in that they do not contain oil but rather kerogen, an organic material that must be extracted from mined rock. The shale is found in the Green River Formation in Colorado, Utah and Wyoming. These oil-bearing rock formations have been heralded as the answer to America's energy crisis with ringing statements that the potential is measured in thousands of billions of barrels of oil. However, the feasibility of extracting the oil from the rock depends on many factors: the oil content of the rock, its accessibility and the thickness of the deposits.

Oil shale contains much less energy than coal, thus incredibly large amounts must be extracted and processed, causing various environmental difficulties.

H. TAR SANDS

If oil shale may be termed the forbidden fruit of the Rocky Mountains, there is an even more sequestered solid fossil fuel in the form of a bitumen called tar sands. U.S. resources in this category may approach 30 billion barrels of locked in oil but it cannot be considered economical at the time. The tar sands are found primarily in Utah where the deposits range from a few feet to several hundred feet in thickness. Unlike oil deposits, these tar sand reservoirs have little if any energy to drive the hydrocarbon from the

Texas should be ripe for tar sand exploration. Are you familiar with this process going on in the state?

formation, so it must be removed mechanically and recovered by hot water extraction. Again the requirement for water is a limiting factor in the possible exploitation of this fuel resource. Farther to the north in Alberta, Canada, the Athabascan deposits are estimated to contain 400 billion barrels of oil of which 27 billion barrels have a 100 foot overburden with an equal volume to be found at or above a 250 foot depth. Huge earth-moving operations are involved in getting at the tar sands and progress has been slow in winning this fuel resource from the earth. One U.S. oil company pulled out of the Athabascan tar sand project after investing over $100 million in the activity.

I. PROBLEMS

Some current problems in utilizing certain potential energy sources include the following: we are not yet able to produce a controlled, continuous fusion reaction (which would assure us of an abundant supply of energy). The energy costs of extracting oil from tar sands and shales and the environmental impact of any such activity make this energy source almost impossible to tape in the near future. The technological problems involved in developing ocean or thermal energy place this energy source far in the future as a common and abundant source of energy. Much research is being done in each of these areas but it is not concentrated

Discuss these questions as they relate to your specific area of residence.

What are the trade-offs involved in developing some of these alternate sources of energy?

in any one area or funded by any central organization. Each research institute concentrates on its particular interest. Many organizations are working at odds because they do not have one common goal. Some are concerned with preserving the environment at any cost, some are desirous of opening federal lands to mining and other development. Our free and democratic society has actually enouraged the greatest waste of resources that takes place anywhere in the world today.

SUMMARY

Faced with the reality of depleting fossil fuels, we must apply all reasonable conservation techniques and try to use our present energy resources more efficiently in order to extend the useful period of these fuels while alternative sources are developed.

Figure shows world energy consumption through the year 2040. With oil suppliers peaking about 1995, the sharpest rise in energy supply will have to come from nuclear power and solar energy. Alternative energy sources must be developed. Geothermal, wind, and ocean sources are just some of the more promising ideas being discussed today.

What are the economic implications to utility companies, auto industries, gasoline companies, etc? Why is Texas not developing solar energy or other alternate sources of energy faster than what they are? It is not because Texas does not have the sunshine.

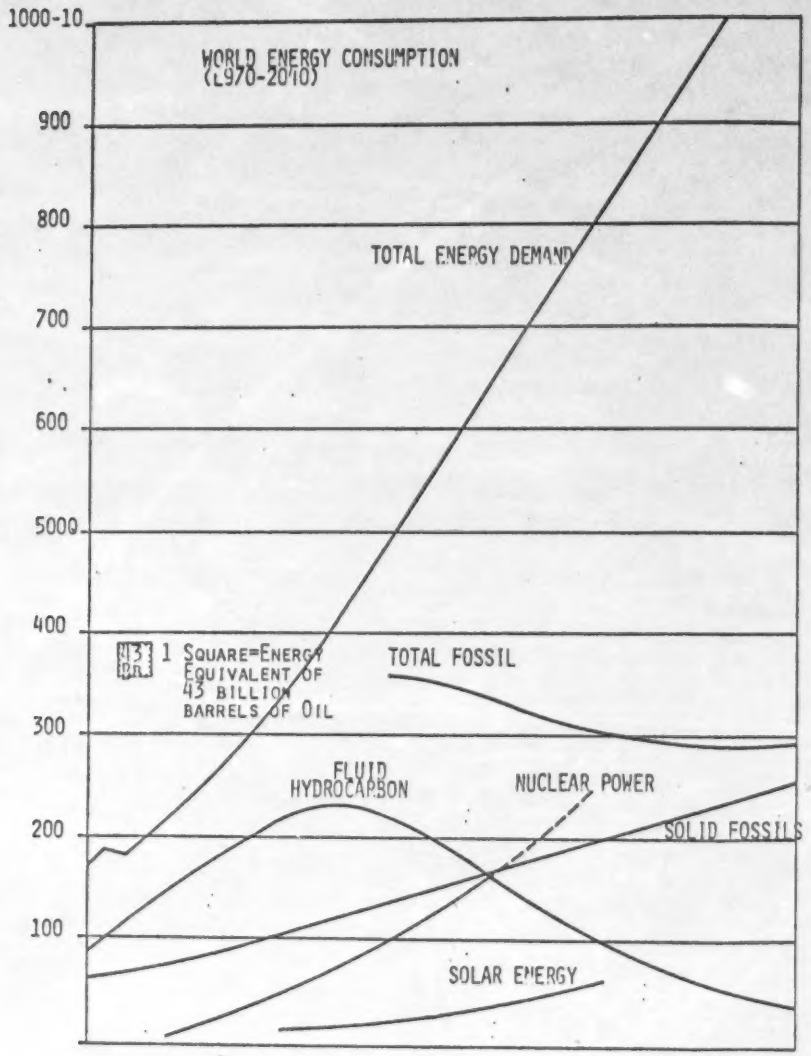

1000-10
WORLD ENERGY CONSUMPTION
(1970-2010)
900
800
TOTAL ENERGY DEMAND
700
600
5000
400
1 SQUARE=ENERGY EQUIVALENT OF 43 BILLION BARRELS OF OIL
TOTAL FOSSIL
300
FLUID HYDROCARBON
NUCLEAR POWER
200
SOLID FOSSILS
100
SOLAR ENERGY

FIG. 2.1.

MODULE #1

AWARENESS OF THE ENERGY DILEMMA

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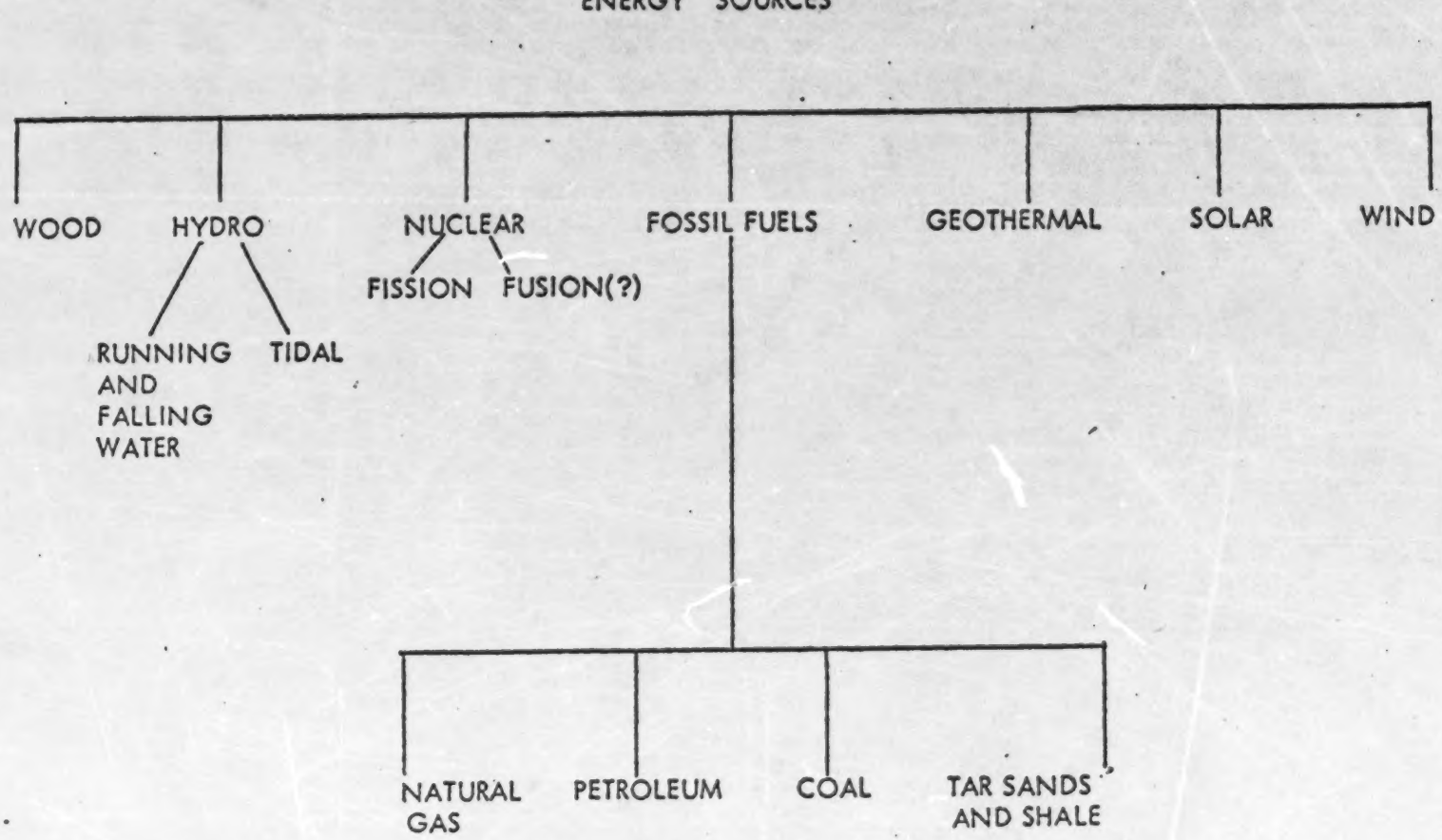
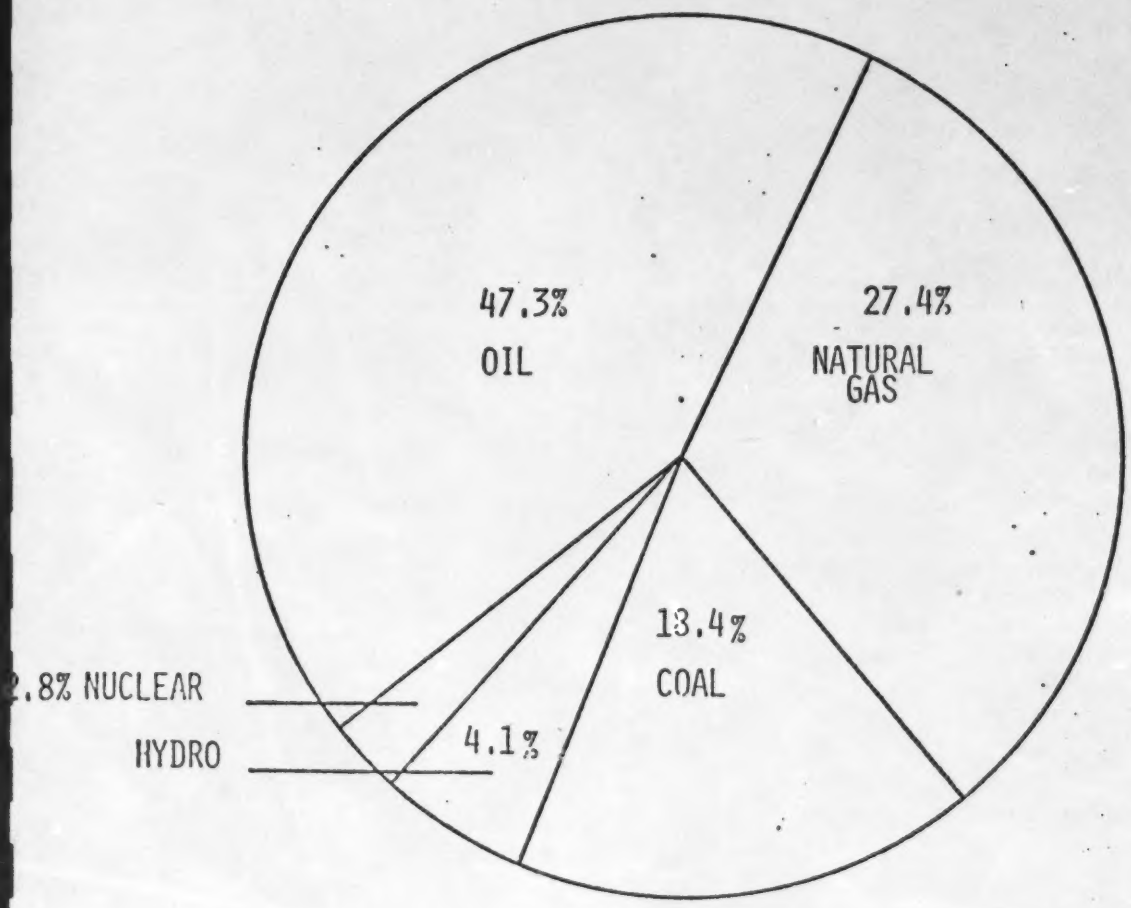

ENERGY SOURCES
WOOD
HYDRO
NUCLEAR
FOSSIL FUELS
GEOTHERMAL
SOLAR
WIND
RUNNING AND FALLING WATER
TIDAL
FISSION
FUSION(?)
NATURAL GAS
PETROLEUM
COAL
TAR SANDS AND SHALE

FIGURE 1.1

HOW U.S. ENERGY NEEDS ARE SUPPLIED

HOW MUCH OF OUR ENERGY COMES FROM EACH SOURCE?



U.S. TOTAL ENERGY SUPPLY

FIG. 1.2

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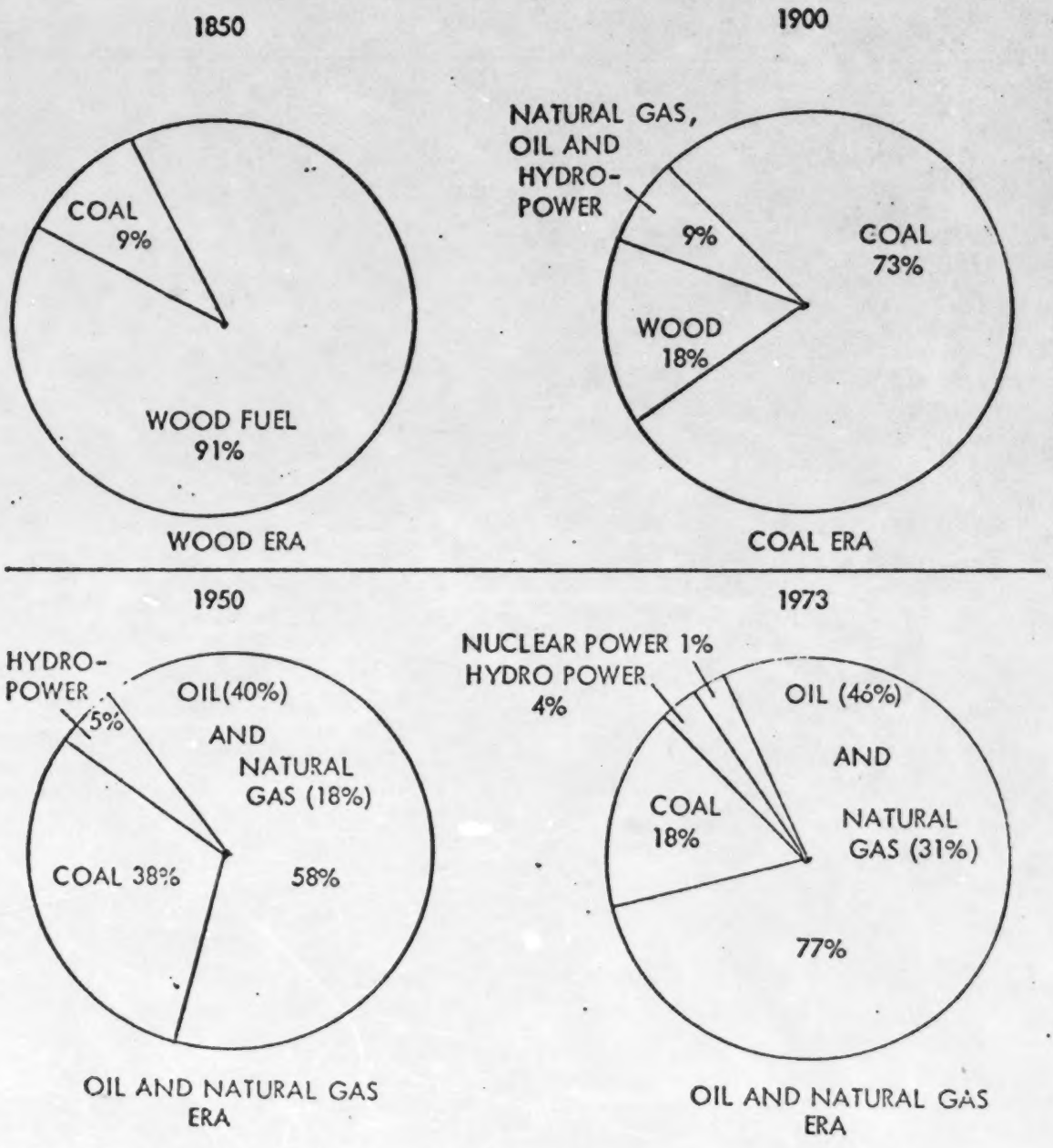
CHANGING PATTERNS IN THE USE OF ENERGY RESOURCES IN THE UNITED STATES



What will the year 2000 bring? NUCLEAR FISSION ERA? NEW COAL ERA? NUCLEAR FUSION, GEOTHERMAL, SOLAR, WIND ERA? ENERGY CONSERVATION ERA? LOWER PER CAPITA ENERGY USE?

Data from the U.S. Bureau of Census and Resources for the Future.

FIGURE 1.3

DEPLETION RATES

CYCLE OF WORLD OIL PRODUCTION

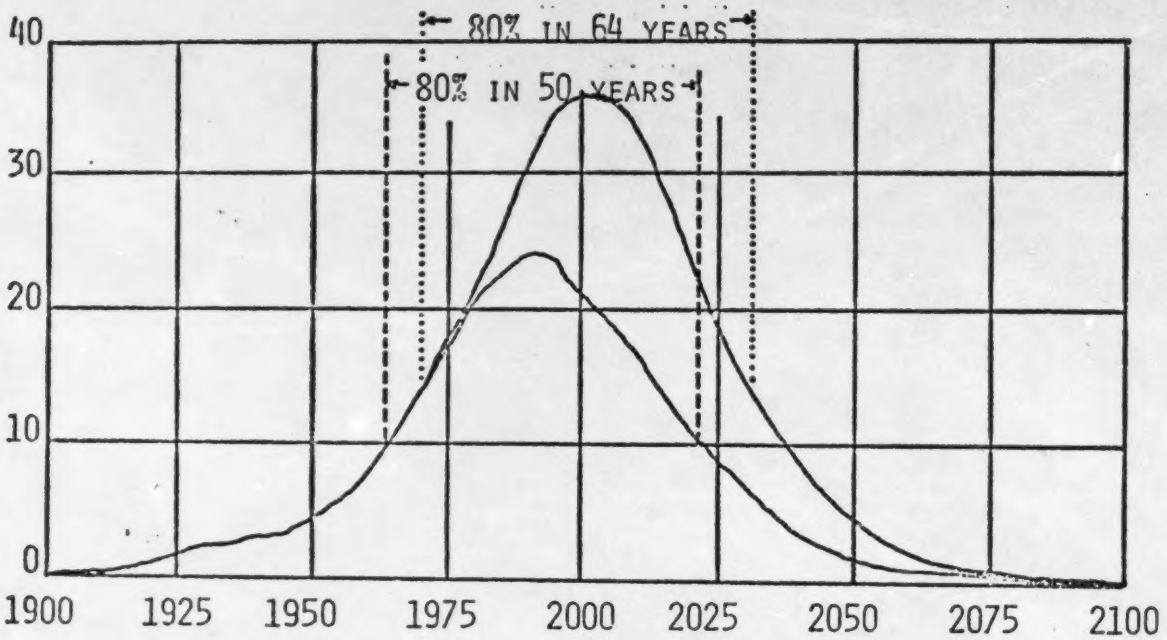


FIGURE 1.4

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DEPLETION RATES

CYCLE OF WORLD COAL PRODUCTION

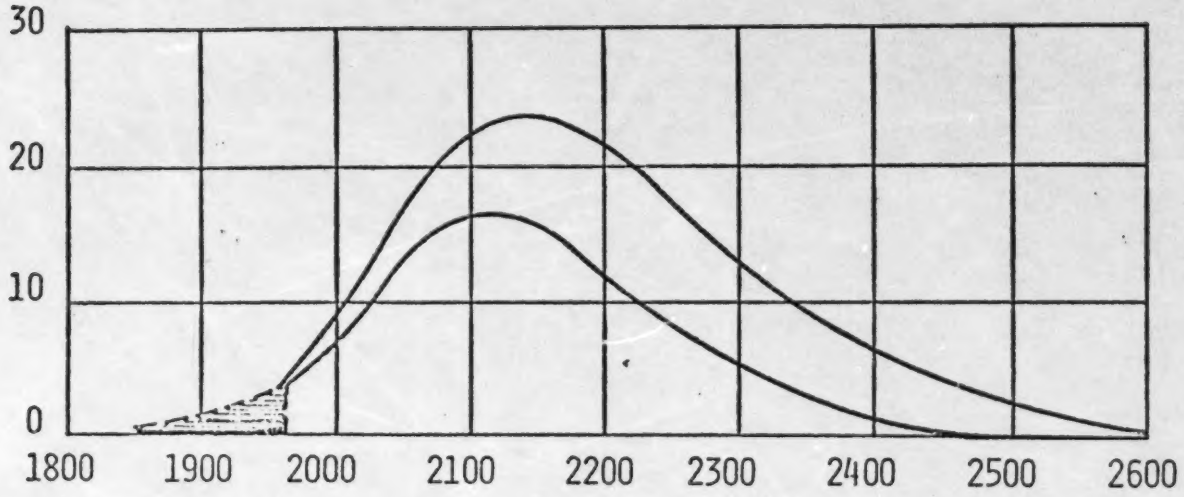

FIGURE 1.5

FIGURE 1.6

HOW MUCH ENERGY DOES EACH PERSON USE IN A YEAR?

An American	300 million BTU/year
A German	150 million BTU/year
A Russian	130 million BTU/year
A Puerto Rican	100 million BTU/year
A Chilean	40 million BTU/year
THE WORLD AVERAGE	35 million BTU/year
A Chinese	13 million BTU/year
An Indian	5 million BTU/year
A Nigerian	1.5 million BTU/year
A Nepalese	.3 million BTU/year

Source: "Energy Conservation: Understanding and Activities for Young People", (FEA/D-75/264) U. S. Government Printing Office, Washington, DC 20402

FIGURE 1.7

THREE TYPES OF ENERGY CRISIS

TYPE OF CRISIS	CONSEQUENCE	ACTION
ACUTE	NATIONAL BANKRUPTCY	TURN DOWN OR SWITCH OFF
CHRONIC	HIGH ENERGY COSTS REQUIRING ADJUSTMENT IN BALANCE OF USE OF BOTH NATIONAL AND INDIVIDUAL RESOURCES	DESIGN BUILDINGS TO BE THERMALLY EFFICIENT
TERMINAL	EXHAUSTION OF FOSSIL FUELS	DEVELOP ALTERNATIVE AND RECYCLABLE SOURCES OF ENERGY

SOURCE: PETER BURBERRY, BUILDING FOR ENERGY CONSERVATION, 1978.

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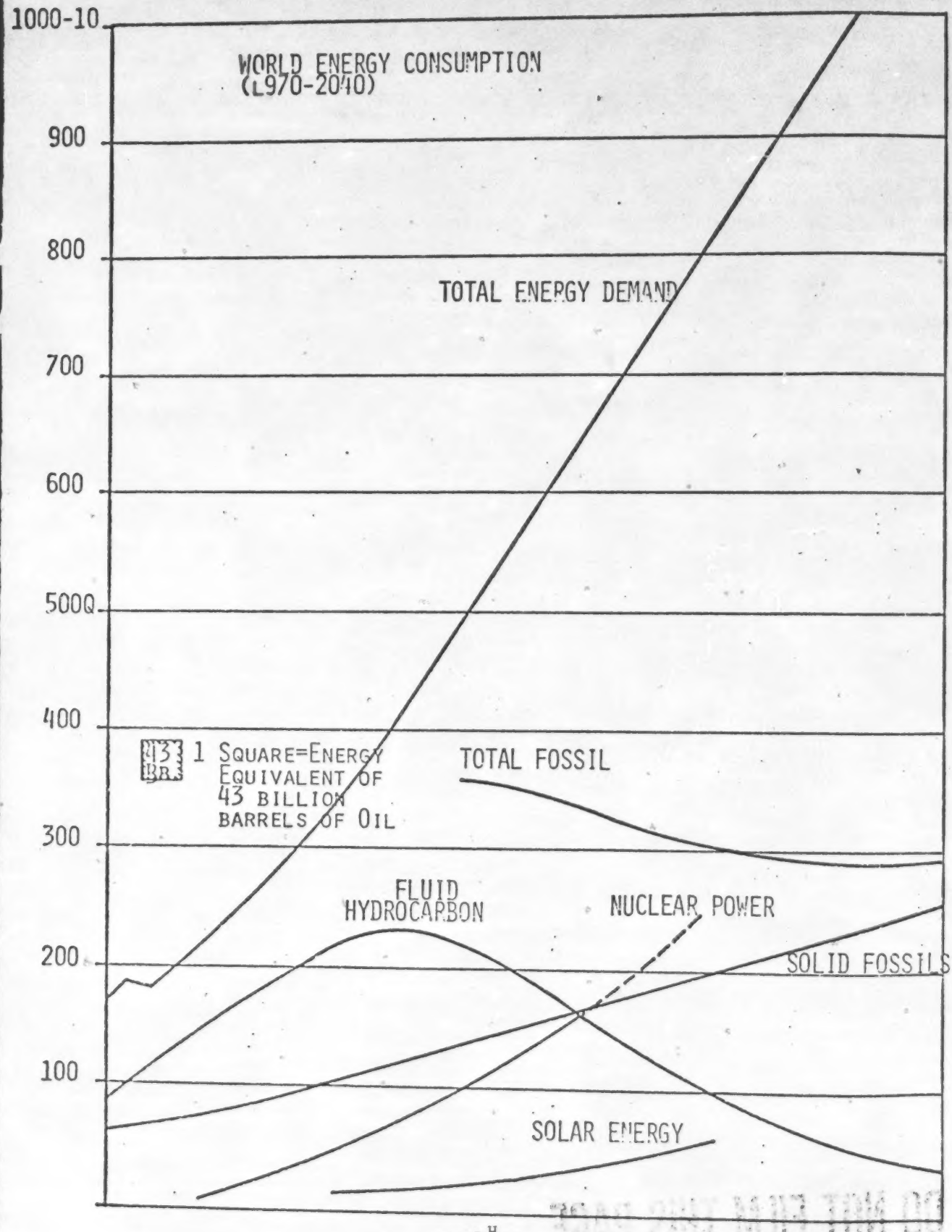
1000-10
WORLD ENERGY CONSUMPTION
(1970-2040)
900
800
TOTAL ENERGY DEMAND
700
600
500Q
400
1 SQUARE=ENERGY EQUIVALENT OF 43 BILLION BARRELS OF OIL
TOTAL FOSSIL
300
FLUID HYDROCARBON
NUCLEAR POWER
200
SOLID FOSSILS
100
SOLAR ENERGY

FIG. 2.1.